Rebuild Massachusetts

PARTNER:
REBUILD BOSTON

SECTOR:
MULTIFAMILY PUBLIC HOUSING

COST & SAVINGS

- Mid-rise Building: $20,000,000
- Renewable Energy Features: 2.6% of overall construction cost
- Energy Efficiency Features: 1% of overall construction cost
- Projected Net Annual Cost Savings: $61,641

KEY DESIGN ELEMENTS

- Solar PV
- Gas Cogeneration
- Gas Chiller
- Energy Star
- Green Features

MAVERICK LANDING

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Measured Energy Performance

In 2001, the United States Department of Housing and Urban Development (HUD) awarded the Boston Housing Authority (BHA) a $35 million grant, making the Maverick Landing redevelopment project possible. In addition to the money from the HOPE VI grant from HUD, the BHA provided approximately $13.5 million in capital funds. The total project cost was about $121 million. Other funding sources included the City of Boston Department of Neighborhood Development and Neighborhood Housing Trust, Commonwealth of Massachusetts, Massachusetts Technology Collaborative, MassHousing, Apollo Housing Capital and Nationwide Insurance. The development electric and gas utilities, NSTAR Electric and Keyspan Energy Delivery, played a major role in the success of this project through their energy conservation programs.

Located on the East Boston waterfront and just outside Maverick Square, Maverick Landing offers a variety of living arrangements for low- and moderate-income individuals and families. Guided by LEED standards, the development aggressively pursued energy savings and associated green building and healthy housing design and construction best practices.

A unique feature of the redevelopment is the green building initiative (at the phase one mid-rise building) made possible through a grant from the Massachusetts Technology Collaborative. The grant allowed the implementation of measures that produce valuable energy savings and new sources for renewable energy. Green building features include rooftop solar photovoltaic panels, energy efficient fiberglass windows, durable insulation and air sealing, EnergyStar appliances, lighting, and motors, and integrated pest management measures.

Most of the primary equipment (PV system, 60 kW gas-fired cogeneration system, and Broad absorption chiller/boiler) have online real time monitoring capability. Additionally, the common electric, gas, and water utility bills are available online and each apartment's electric meter can be read manually each month.

The design and construction process included detailed energy modeling (DOE-2)[1]. In August 2005, Rebuild Massachusetts requested US DOE National Laboratory technical support to assist with the analysis of actual building performance.

KEY TO SUCCESS

- **Identify and recruit candidate projects as early in the design process as possible by making use of housing agency contacts or designating a position responsible for this function.**
- **Meet with major developers to understand fully their needs, interest, and concern s.**
- **Be clear with developers about the available clean energy resources and the requirements to access them.**
- **Whenever possible, work through existing housing support channels to minimize additional administrative burdens on the developer.**
- **Identify or provide an 'energy project champion' on the development team to work with the developer.**
- **Assist developers to address PV related technical questions and issues through referrals or direct support.**

Source: Clean Energy State Program Guide, February 2006

[1] Dynamic Interactions and Competing Objectives in Multifamily Green Building Design by John Snell and Ken Neuhauser at http://www.mass.gov/Eoca/docs/doer/dicomgbd-a.pdf.

Technical Assistance

The United States Department of Energy and the Massachusetts Division of Energy Resources provided significant technical assistance throughout the development of this project through the Rebuild America Program. The Rebuild Massachusetts Program funded our technical support contractor Peregrine Energy Group to identify energy and water saving opportunities and analyze the building's potential performance. Based on Rebuild's technical support Maverick Landing hosted the installation of several energy efficiency and renewable energy technical innovations with significant financial support from utility system benefit charge funds.

As an important follow up task, Rebuild Massachusetts worked with the development's management team (when they completed construction and residents moved in) to confirm that the building and energy-related equipment performance was as projected. Rebuild Massachusetts technical support contractor and project partners reviewed monthly utility bills and visited the development regularly to observe the equipment operation and to install temperature and humidity data loggers in apartments and common areas. This effort included a third party review of the building's energy performance by DOE Rebuild America research staff at Pacific Northwest National Laboratory (PNNL).

For the third party building performance review DOE research staff reviewed the technical specifications for the equipment, guided the installation of the data loggers, reviewed the original energy modeling (DOE 2) calculations and assumptions, and recalibrated the energy model to the development's actual bills, data logger readings, and energy control system trend log readings. Rebuild's project partners Peregrine Energy Group, Conservation Services Group, and Boston Housing Authority presented the results of these findings at the Multifamily Buildings conference in New York City in June 2006.

Equipment Performance Summaries

Rebuild Massachusetts performed a detailed analysis of the utility bills that compared the energy and water consumption projections with the first year of actual energy and water consumption. As seen in tables 1 and 2, actual energy and water consumption for the first year was relatively close to the projected consumption; actual energy use and cost was slightly higher than projected and actual water use and cost was lower than projected.

In addition to a detailed utility analysis, Rebuild reviewed the performance of the individual renewable energy and high efficiency equipment components installed at Maverick. Generally, the equipment was complicated and more challenging to integrate into the building than standard efficiency equipment that the developer normally installs in multifamily buildings.

Table 1: First Year Energy & Water Consumption

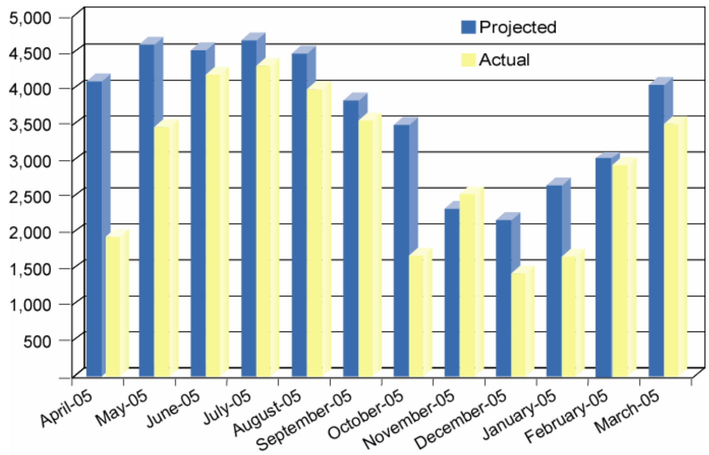
End Uses	Target Total Use	Actual Total Use		Percent Difference
Gas Heating, AC, Cogeneration, and DHW	76,390	88,000	Therms	15%
Apartment Lights & Appliances	435,400	350,000	kWh	-20%
Common Area Electricity	216,264	40,800	kWh	-81%
Water	10,452	5,475	CCF	-48%

Table 2: First Year Energy & Water Cost

End Uses	Target Total Use	Actual Total Use	Percent Difference
Gas Heating, AC, Cogeneration, and DHW	$84,429	$105,087	24%
Apartment Lights & Appliances	$65,310	$45,500	-30%
Common Area Electricity	$21,626	$20,400	-6%
Water	$62,714	$43,800	-30%
Total	$234,079	$214,787	-8%

Solar PV - Figure 1 summarizes the PV equipment performance at Maverick Landing. The system generates slightly less than projected electricity. The five months with significantly lower kWh output indicate periods when the system was being worked on.

Figure 1: Solar PV System kWh Output



Double absorption chiller – Table 3 summarizes the target savings for the double absorption chiller installed at Maverick. The estimated gas use of about 18,000 therms was 20% higher than projected. The estimated gas cost for cooling based on actual gas bills was about $22,000 or 50% higher than projected. The primary driver for the higher cost was a significant price increase in the cost per therm ($1.18/ therm instead of $.55/ therm).

Table 3: Target Gas Chiller Cost Savings

Air conditioning System	Total Fuel Cost	Per Apartment Fuel Cost	Total Use	Per Apartment Use	Average Price	Note
Electric Chiller (kWh)	$54,338	$457	54,338	457	$0.22	per kWh
Gas Chiller (kWh)	$3,167	$27	3,167	27	$0.21	per kWh
Gas Chiller (Therms)	$15,052	$126	15,052	126	$0.55	per Therm
	$18,219	$153				
Net Cost Savings	$36,119	$304				

Ventilation system – As part of the high performance building design the development team sealed cracks and holes between apartments as an alternative to LEED's "no smoking allowed" requirement and installed fresh air supply grilles to each apartment. The target air leakage requirement was an effective leakage area (ELA) of 1.25 square inches per 100 square feet of apartment surface area at 50 Pascals of pressure. The target airflow for the inlet supply grilles was 30-60 cfm per apartment. Measured leakage in a few selected apartments ranged from .73 to 1.90 ELA/ 100. Some apartments were below the standard and some apartments were above the standard. The average measured airflow supply in a few selected apartments was about 20 cfm with the fan blowers running in the apartment vertical fan coils. This is slightly below the target inlet airflow rate.

Figure 4: Fresh Air Supply

Cogeneration system – Figures 2 and 3 compare the thermal load performance of the cogeneration system in the first winter and summer. The cogeneration system ran at 60% output 24 hours per day during these two periods. The system provides electricity for the common areas and thermal energy for heat and domestic hot water for the apartments. Based on the cogeneration system's thermal performance and electric and gas rate structures the cogeneration system is most cost-effective when it runs during the peak electric hours (9-6 summer, 8-9 winter) and least cost-effective during off-peak electric hours.

Figure 2: Winter Cogeneration Performance

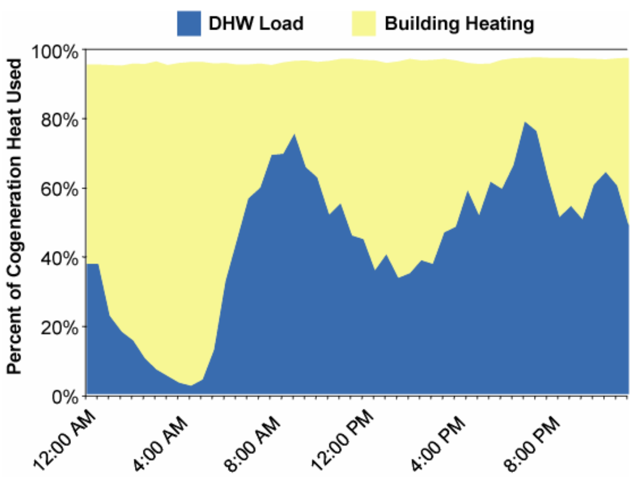
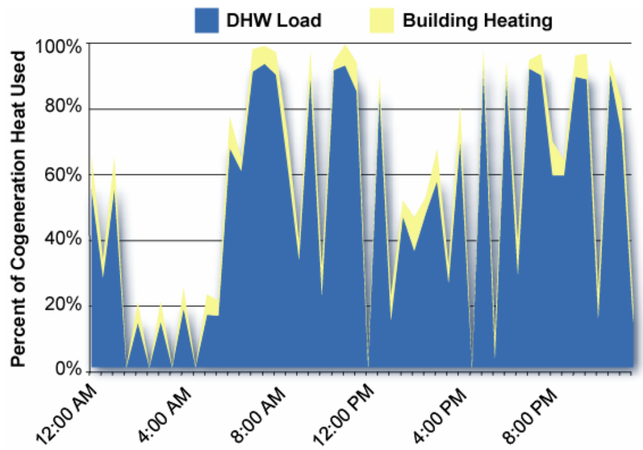


Figure 3: Spring Cogeneration Performance



Individual electric meters – In Boston, most public housing developments have centrally metered electricity. This was true for the Maverick development until it was torn down, replaced with new buildings, and individually metered for electricity. Figures 4 and 5 demonstrate the impact that individual utility bills had on the electricity consumption for each apartment. There are a number of reasons why the utility bills were higher the first month, however, the simple message is that high utility bills caught the residents' attention and their utility consumption dropped significantly and remained lower than the first month's bills in the following months.

Figure 4: First Electric Bill (4/2/05)

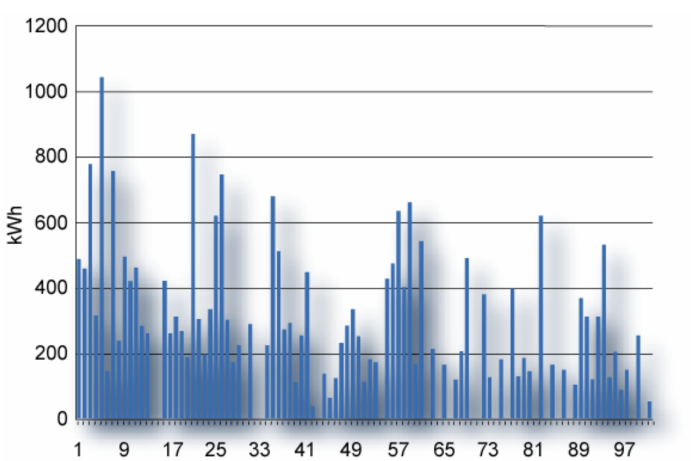


Figure 5: Second Electric Bill (4/29/05)